Guidelines for growing grain legumes in Europe
**A well-balanced raw material**

Legume seeds are rich in protein and energy. Due to their high lysine content, they are a good complement for cereals and may promote more efficient use of protein, by meeting animal requirements more precisely and by reducing the nitrogen surplus excreted in animal urine. All grain legumes can be used as whole seed except for soyabean which requires processing to remove excess oil and to reduce antitrypsic activities.

**Sources:** INRA, France (2002); *Io7 Banque de données de l'alimentation animale - AFZ, France (2001); **GRDC, Australia (1997); nd = no data available.

### Which grain legume for which animal?

Grain legumes are suitable for a wide range of uses and for feeding all animals. Their incorporation into compound feed products depends on the selected species and variety, as well as the growth stage of the animals.

This table takes into account only the nutritional adaptability of each species.

### Maximum incorporation rates

The maximum incorporation rate for grain legumes used in the compound feed industry can vary greatly depending on the country, but also on the manufacturer: the maximum incorporation rate for peas in diets for finishing pigs can range from 10% to 40% in Europe. There are several reasons for this situation: use of different scientific references, specific experience of the manufacturer, level of knowledge of this raw material in the region, availability of other substitutable raw materials.

### Various uses

Most grain legumes are used as high quality raw material for the animal compound feed industry. Yet, they have other uses:

- on-farm use (as forage or grains), especially in organic farming systems,
- human food for export and home consumption (mainly pea, chickpea and faba bean),
- niche markets (pigeon feed, food ingredients, etc.).

### What are the components of grain legumes?

<table>
<thead>
<tr>
<th>Components (%)</th>
<th>Wheat</th>
<th>Pea</th>
<th>Faba bean</th>
<th>Common vetch*</th>
<th>Bitter vetch*</th>
<th>Chickpea Desi*</th>
<th>Blue lupin</th>
<th>White lupin</th>
<th>Yellow lupin**</th>
<th>Soybean seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteins</td>
<td>12</td>
<td>24</td>
<td>29</td>
<td>28</td>
<td>26</td>
<td>34</td>
<td>38</td>
<td>42</td>
<td>39</td>
<td>**</td>
</tr>
<tr>
<td>Starch</td>
<td>69</td>
<td>51</td>
<td>43</td>
<td>43</td>
<td>nd</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fats</td>
<td>1.7</td>
<td>1.1</td>
<td>1.7</td>
<td>1.6</td>
<td>1.1</td>
<td>6.1</td>
<td>5.9</td>
<td>9.5</td>
<td>6.1</td>
<td>20</td>
</tr>
<tr>
<td>Ash</td>
<td>1.8</td>
<td>3.5</td>
<td>4</td>
<td>4</td>
<td>3.3</td>
<td>3.2</td>
<td>3.8</td>
<td>3.9</td>
<td>3.8</td>
<td>5.9</td>
</tr>
<tr>
<td>Crude fibres</td>
<td>2.5</td>
<td>6</td>
<td>9.3</td>
<td>4.5</td>
<td>4.1</td>
<td>10</td>
<td>18</td>
<td>13</td>
<td>18</td>
<td>5.9</td>
</tr>
<tr>
<td>Lysine</td>
<td>2.9</td>
<td>7.3</td>
<td>6.5</td>
<td>5.7</td>
<td>6.4</td>
<td>6.8</td>
<td>5</td>
<td>4.9</td>
<td>5.3</td>
<td>6.2</td>
</tr>
<tr>
<td>Methionine + cysteine</td>
<td>4</td>
<td>2.3</td>
<td>2</td>
<td>1.8</td>
<td>2.4</td>
<td>2</td>
<td>2.6</td>
<td>2.4</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>Threonine</td>
<td>3.1</td>
<td>3.8</td>
<td>3.6</td>
<td>3.3</td>
<td>3.8</td>
<td>3.4</td>
<td>3.9</td>
<td>3.7</td>
<td>3.5</td>
<td>4</td>
</tr>
<tr>
<td>Tryptophane</td>
<td>1.2</td>
<td>0.9</td>
<td>0.8</td>
<td>nd</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>1.3</td>
</tr>
</tbody>
</table>

### Table of amino acids (% protein)

<table>
<thead>
<tr>
<th>Amino acids (%)</th>
<th>Wheat</th>
<th>Pea</th>
<th>Faba bean</th>
<th>Common vetch*</th>
<th>Bitter vetch*</th>
<th>Chickpea Desi*</th>
<th>Blue lupin</th>
<th>White lupin</th>
<th>Yellow lupin**</th>
<th>Soybean seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysine</td>
<td>2.9</td>
<td>7.3</td>
<td>6.5</td>
<td>5.7</td>
<td>6.4</td>
<td>6.8</td>
<td>5</td>
<td>4.9</td>
<td>5.3</td>
<td>6.2</td>
</tr>
<tr>
<td>Methionine+cysteine</td>
<td>4</td>
<td>2.3</td>
<td>2</td>
<td>1.8</td>
<td>2.4</td>
<td>2</td>
<td>2.6</td>
<td>2.4</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>Threonine</td>
<td>3.1</td>
<td>3.8</td>
<td>3.6</td>
<td>3.3</td>
<td>3.8</td>
<td>3.4</td>
<td>3.9</td>
<td>3.7</td>
<td>3.5</td>
<td>4</td>
</tr>
<tr>
<td>Tryptophane</td>
<td>1.2</td>
<td>0.9</td>
<td>0.8</td>
<td>nd</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>1.3</td>
</tr>
</tbody>
</table>

* with low incorporation rates (<3%) for some growth stages of pigs.
Source: GL-Pro associated experts.
Grain legumes for all tastes!

Grain legumes are plants belonging to the leguminosae (or fabaceae) family, which also includes forage legumes. They are cultivated primarily for their grains, which are used either for human consumption or for animal feed – the focus of this leaflet. The grains, which are rich in protein, are harvested at maturity and marketed as dry products.

Beneficial for the following crop

A grain legume grown as a break crop, has positive effects on soil structure enabling minimum tillage, on root diseases reduction and on nitrogen efficiency. In addition the following crop (usually a cereal) yields more and requires fewer herbicide and fungicide treatments. On average wheat yields 0.8 t/ha more after peas, than after cereal.

Environment-friendly crops

Unlike other cultivated plants, grain legumes do not need nitrogen fertilisers to grow well. This is because they form root nodules which contain symbiotic nitrogen-fixing bacteria. Atmospheric nitrogen fixation by grain legumes crops is a significant economic and ecological advantage in a crop rotation.

A home-grown crop to replace imports

In the European Union (EU) the demand for protein-rich animal feed greatly exceeds the level of home production. This makes the EU highly dependent on imports: over 75% of Materials Rich in Protein (>15% protein), mainly soyabeans, are imported for use by the compound feed industry. Grain legumes could play a significant part in any initiative to increase the home-production of protein-rich raw material for animal feed in the EU.
Grain legume cultivation: great potential for development

GRAIN LEGUME CROPS could offer many benefits if they were grown more widely in European crop rotations. They offer great possibilities for increase since they constitute only 1% to 7% of the arable crops area in different EU countries, compared with 15% to 25% outside Europe.

PEA is the main protein crop cultivated in the EU. In 2004 the area sown in the EU-15 was 790,000 ha. France is the largest producer (60% of EU production), well ahead of Germany and the United Kingdom. The pea crop has decreased significantly in Denmark, but it is increasing in Spain.

FABA BEAN is the second most cultivated grain legume in the EU. Its area of production has increased recently (390,000 ha in the EU-15 in 2004), especially in the United Kingdom and France.

LUPIN (about 230,000 ha in 2004) is grown only in Italy, France and Austria.

VETCHES (267,000 ha of common and bitter vetches) and CHICKPEA (88,000 ha) are produced almost solely in Spain and in a few other Mediterranean countries.

Different markets, different prices

THE STANDARD PRICES of grain legumes for feed use are closely correlated with the world prices for wheat and soya meal. Nevertheless, some specific outlets, such as the food market (yellow pea for the Indian subcontinent and faba bean for Egypt) can influence this price. Some niche markets, such as the pigeon market for peas in the UK or the food ingredient market for lupins, can lead to much higher prices. In these cases, contracts are negotiated between the farmer and the manufacturer.

Grain legumes and the current CAP reform

The new Common Agricultural Policy (CAP) reform will come into force between 2005 and 2007 (depending on the decisions of individual countries). The 'decoupling' of aid (a single farm payment irrespective of the crops) is the key feature of this reform. The consequences for grain legumes, vary according to the species:

- for the so-called 'protein crops' (field pea, faba bean, lupins): a specific payment of €55.57/ha, with a Maximum Guaranteed Area of 1.6 million hectares (EU-25);
- for chickpeas, lentils and vetches and all other species: integration into the single payment scheme.

Economic benefits

The variable production costs for grain legumes are lower than for cereals. These are mainly the costs of seeds and harvesting. Yields vary greatly between species, regions and growing seasons because of climatic effects. Yields can be stabilised with improved varieties and technical advances, and this can result in increased productivity in areas which have high production potential.

To quantify the economic benefits of grain legumes, the entire crop rotation must be considered. Higher yields for the following crops, cost savings for fertilisers because of nitrogen fixation and for tillage due to improved soil structure, as well as better management of the high demand for labour in autumn are some of the advantages of grain legumes.
Which grain legume for which regional conditions?

Among the grain legume species, peas are the most versatile in Europe: they can be grown almost anywhere. Their high yield potential makes profitable use of fertile soils, most of the new varieties are easy to harvest, and peas can be used for several outlets. Other grain legume species can be grown easily on most farms, especially when:

1. there is a better adaptation to the type of soil and location;
2. there is a specific market demand, with more attractive prices or a specific use due to the composition of the grain;
3. there is a need to grow other species in the same land in order to diversify the rotation and to avoid pea root diseases. Consequently there will be at least one best-suited grain legume species for almost all farms and others to diversify the rotation.

Potential growing areas for grain legumes

The objective of these maps is to provide an indication of the potential area for cultivation of each grain legume crop. This is the area where it is possible to grow the crop, taking into account the soil and climatic conditions of each region, but without any consideration of yield potential and economic output. The decision to grow one of these crops should not be based on these maps alone. They are designed to show overall possibilities but not recommendations.

Benefits for the following wheat:

1. reduces N fertilisers -20% to -25%;
2. reduces pesticide costs -20% to -25%;
3. increases wheat yields +0.8 t/ha.

Similar results in France, Germany, Austria and England.
**Different types of grain legumes**

Most grain legume species cultivated in Europe are ‘Mediterranean crops’. Soyabean is the only ‘tropical’ grain legume: a crop requiring four months of warm and rainy conditions to reach maturity.

<table>
<thead>
<tr>
<th></th>
<th>Pea</th>
<th>Faba bean</th>
<th>Blue lupin</th>
<th>White lupin</th>
<th>Yellow lupin</th>
<th>Chickpea</th>
<th>Common vetch</th>
<th>Bitter vetch</th>
<th>Soyabean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing types</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. = Spring type sowing periods*</td>
<td>S. and W.</td>
<td>S. and W.</td>
<td>S.</td>
<td>S. and W.</td>
<td>S.</td>
<td>S. and W.</td>
<td>W.</td>
<td>W.</td>
<td>S.</td>
</tr>
<tr>
<td>W. = Winter type sowing periods</td>
<td>end winter</td>
<td>end winter</td>
<td>end winter</td>
<td>end winter</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>spring</td>
<td></td>
</tr>
<tr>
<td><strong>Seed rate (kg/ha)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* for southern parts of Europe, spring types can be sown during the winter.
** except for photoperiod-sensitive varieties: early or mid autumn.

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**How to read these maps?**

- **Potential cultivation**
- **Cultivation not advised**
- **Insufficient information**
- **Irrigation required**

**Spring type**: Sown in spring for southern parts of Europe, can be sown during the winter

**Winter type**: Sown in autumn, possibly in winter
**Which soil?**

Any soil suitable for arable crops is suitable for grain legumes. However, pay special attention to soils susceptible to compaction and waterlogging, as grain legumes require oxygen to fix atmospheric nitrogen in the root nodules, and to calcareous soils which are generally unsuitable for lupins.

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>Pea</th>
<th>Faba bean</th>
<th>Blue lupin</th>
<th>White lupin</th>
<th>Yellow lupin</th>
<th>Chickpea</th>
<th>Common vetch</th>
<th>Bitter vetch</th>
<th>Soyabean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcareous soils active CaCO$_3$ &gt; 2 %</td>
<td>++</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Shallow soils susceptible to drought</td>
<td>+</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Stony soils with lodging and harvesting problems</td>
<td>+*</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Tolerance of waterlogged soils</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>

* only for varieties with good standing ability.

**Which climatic constraints?**

<table>
<thead>
<tr>
<th>Tolerance</th>
<th>Pea</th>
<th>Faba bean</th>
<th>Blue lupin</th>
<th>White lupin</th>
<th>Yellow lupin</th>
<th>Chickpea</th>
<th>Common vetch</th>
<th>Bitter vetch</th>
<th>Soyabean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolerance of high temperature</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>nd</td>
<td>nd</td>
<td>+++</td>
</tr>
<tr>
<td>Tolerance of drought stress</td>
<td>+</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Cycle duration* (Spring types)</td>
<td>1,600</td>
<td>1,900</td>
<td>nd</td>
<td>2,100</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>variable**</td>
</tr>
<tr>
<td>Frost resistance (Winter types)</td>
<td>++ to +++</td>
<td>+ to ++</td>
<td>nd</td>
<td>+</td>
<td>nd</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>-</td>
</tr>
</tbody>
</table>

* in degree.days (*°C.days) Base 0°C; ** different maturity groups.

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**Adaptation/tolerance**

+++: perfect
++: good
+: moderate
-: low
--: avoid
nd: not determined

**Winter**

Soyabean

**Spring**

Winter chickpea

**Common vetch**

**Bitter vetch**
What’s new in grain legume breeding?

European breeders are releasing new varieties regularly and these have improved characteristics. Recently there have been some major advances:

- better standing ability for peas at harvest time, which means that new cultivars can grow in almost any type of soil;
- frost resistance in winter pea, winter faba bean and winter white lupin;
- improved yield potential and low alkaloids content in blue lupin;
- seed quality of faba bean (free from antinutritional factors).

Check-list for growing grain legumes

1. Should I diversify my crop rotation?
2. Which grain legume seems best adapted to my soil and climate conditions?
3. Which outlet for my harvest? If feed use, for which animal?
4. Is there a local integrated chain for the selected crop in order to facilitate the supply of inputs and marketing the product (seeds and chemicals, storage, local buyers)? Contact your co-operative or your advisor.
5. What are the current market prices for grain legumes?

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for further technical information and advice on cropping management
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